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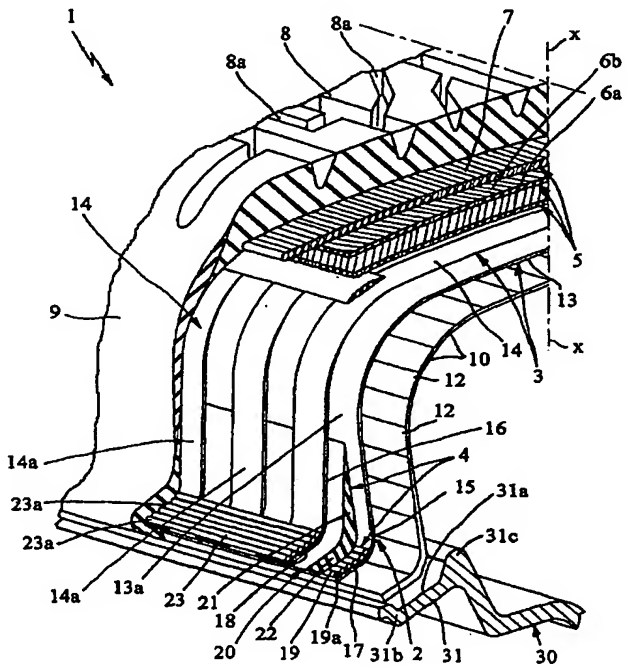
(54) Title: METHOD FOR MANUFACTURING A TYRE FOR VEHICLE WHEELS, TYRE WHICH CAN BE OBTAINED BY SAID METHOD, AND VEHICLE WHEEL COMPRISING SAID TYRE

(57) Abstract

In a tyre for vehicles, the formation of each bead reinforcing structure (4) envisages that, after laying of a first series of elongated sections (13) defining axially inner terminal zones (15) of a carcass ply (3), an annular anchoring insert (19) consisting of a wire wound in axially adjacent turns is formed on an end portion (17) directed axially towards the outside of the respective zone. A stiffening element (20) tapering radially away from the axis of the tyre is then formed on each inner terminal zone (15). A second series of elongated sections (14) is then laid, completing the manufacture of the carcass ply (3) with the formation of axially outer terminal zones (16) which are superimposed on the stiffening elements (20). An additional annular insert (23) is formed on an end portion (18) of each outer terminal zone (16) arranged radially superimposed on the anchoring insert (19). The tyre according to the invention may be associated with a symmetrical rim which has two lateral portions designed to form the bead seats for engagement with the corresponding tyre beads, which are defined by frustoconical surfaces converging towards the axis of rotation of the rim, away from the equatorial plane thereof.



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"METHOD FOR MANUFACTURING A TYRE FOR VEHICLE WHEELS, TYRE WHICH CAN BE OBTAINED BY SAID METHOD, AND VEHICLE WHEEL COMPRISING SAID TYRE"

The present invention relates to a method of manufacturing a tyre for vehicle wheels, comprising the following steps: forming a carcass structure having at least one carcass ply with terminal zones engaged with respective annular reinforcing structures which are axially spaced from one another; applying a belt structure in a position circumferentially outside the carcass structure; applying a tread band in a position circumferentially outside the belt structure and at least one pair of sidewalls in laterally opposite positions on the carcass structure.

The present invention also relates to a tyre for vehicle wheels which can be obtained by means of the above-mentioned method, comprising: a carcass structure having at least one carcass ply with terminal zones engaged with respective annular reinforcing structures axially spaced from one another; a belt structure applied in a position circumferentially outside the carcass structure; a tread band applied in a position circumferentially outside the belt structure; at least one pair of sidewalls applied in laterally opposite positions on the carcass structure.

The invention also relates to a tyre wheel comprising a mounting rim provided with bead seats defined by frustoconical surfaces converging towards the axis of rotation of the tyre, away from the equatorial plane thereof, and a tyre obtained with the method according to the invention provided with beads designed to fit precisely into the above-mentioned seats.

The manufacture of tyres for vehicle wheels involves the manufacturing of a carcass structure essentially composed of one or more carcass plies shaped in a substantially toroidal configuration and having its axially opposite lateral edges engaged with respective annular reinforcing structures, each of which normally comprises a circumferentially unextendable, metal, annular insert, usually called a bead core, and a filling element made of elastomeric material and combined with the bead core in a radially external position.

The carcass structure has, applied to it, in a circumferentially outer position, a belt structure comprising one or more belt layers formed in a closed ring, which are essentially made up of textile or metal cords suitably oriented relative to each other and to the cords belonging to the adjacent carcass plies.
Then, at a circumferentially outer position of the belt structure a tread band is applied, which usually consists of a strip of elastomer material of suitable thickness.

It is to point out that, to the aims of the present description, by the term "elastomer material" it is intended a rubber blend in its entirety, i.e. the assembly formed of at least one base polymer suitably amalgamated with reinforcing fillers and/or process additives of various types.

Ultimately, a pair of sidewalls is applied to the opposite sides of a tyre being manufactured, each of said sidewalls covering a side portion of the tyre comprised between a so-called shoulder region, arranged close to the corresponding side edge of the tread band, and a so-called bead arranged at the corresponding bead core.

The traditional production methods essentially envisage that the above listed tyre components are first made separately from one another, to be then assembled during a step of the tyre manufacture.

Production methods have also been proposed, whereby, instead of resorting to the production of semi-finished products, part or all of the carcass structure components are made directly during the tyre manufacturing steps.

For example, US Patent 5,453,140, discloses a method and an apparatus which form a carcass ply by laying down, on a toroidal support shaped so as to match the tyre, a plurality of cord sections arranged circumferentially in side by side relationship and sequentially obtained by cutting an individual cord supplied from a reel.

For the purposes of manufacturing the annular reinforcing structures, it is also known that, in the vicinity of each of the tyre beads, the opposite ends of the individual cords forming a carcass ply are arranged, in an alternate sequence, in axially opposite positions with respect to an annular anchoring insert formed substantially in the manner of a circular crown and composed of coils of metal wire arranged in concentric circumferences, as can be understood from the patent EP 0,664,231 and the patent US 5,702,548.

In the above mentioned art, all the cords forming the carcass ply or plies are however substantially arranged along the neutral axis of resistance to bending of the respective bead. Under this circumstance, the structural strength of the beads must necessarily rely on the rigidity of the filling inserts made of very hard elastomer material incorporated into the bead structure,

the behaviour of which is affected by temperature changes due both to environmental factors and to stresses induced during normal operation.

The Applicant has found that important advantages can be achieved both in terms of simplification in the production processes and in terms of improvement of the behavioural features of the tyre if the carcass ply or plies are made by suitably laying down strip-like sections on a rigid toroidal support, each comprising a plurality of cords parallel to each other, incorporated into an elastomer layer.

In this connection, the Applicant has already developed different manufacturing methods being the object of respective European Patent Applications.

For instance, in European Patent Application Nos. 97830731.2 and 97830733.8 a manufacturing method and a tyre are respectively disclosed in which the carcass structure is obtained by making a first and a second carcass plies, each obtained by means of strip-like sections sequentially laid down in circumferential mutual side by side relationship.

Tyres obtained following the method described in such patent applications have the end portions of the strip-like sections belonging to the first and second carcass plies disposed on respectively opposite sides relative to the annular reinforcing structures of the beads.

This expedient, in combination with the respectively crossed orientation of the strip-like sections belonging to one and the other plies, offers considerable advantages in terms of structural strength of the tyre close to the beads and sidewalls.

In the European Patent Application No. 98830472.1, in the name of the Applicant as well, accomplishment of a carcass ply is proposed which is made by laying down a first and a second series of strip-like sections in an alternate sequence, the sections belonging to the first and second series terminating at respectively opposite sides relative to the bead reinforcing structures.

Thus, advantages can be achieved in terms of structural strength at the tyre beads and sidewalls, even in the presence of a single carcass ply.

Usually tyre beads, and in particular the annular reinforcing structures integrated thereinto, are conceived and shaped in a manner suitable for coupling with the respective circumferential seats provided on a rim with which the tyre is to be associated, for the purpose of ensuring a steady connection between these two wheel components.

In greater detail, the engagement between each bead and the corresponding circumferential seat of the rim is such that the bead is constantly pushed, owing to the inflation pressure of the tyre, against an abutment shoulder projecting radially away from the axis of rotation of the tyre and defining the axially external edge of the rim. At least in tubeless tyres, i.e. those without inner tubes, each circumferential seat for engagement of the bead has a frustoconical surface - usually called a "bead seat" - having an extension converging towards the rotation axis into the vicinity of the equatorial plane of the tyre. Each bead, which is pushed axially away from the equatorial plane owing to the inflation pressure, acts in an axial thrust relationship against the respective bead seat so as to

ensure a perfect hermetic seal for the air contained in the tyre.

Recently vehicle wheels have been proposed, in which the engagement seats of the tyre beads have a frustoconical shape with a progression converging towards the axis of rotation away from the equatorial plane. An example of such a rim/tyre assembly is described in the American patent US 5,634,993.

In the embodiment proposed in this patent, the tyre beads, which are shaped so as to match the corresponding seats on the rim, have annular reinforcing structures comprising usual bead cores around which the terminal zones of the carcass ply are axially folded back. The carcass structure, which is of the radial type, has overall a cross-sectional profile with a constant bending direction, the tangent of which close to the bead cores is substantially parallel to the equatorial plane.

The document WO 95/23073 describes a tyre with beads which are particularly suitable for use on rims with frustoconical bead seats axially turned outwardly.

In the Applicant's perception, the technical problem to be solved in this tyre is that of modifying its structure so as to facilitate the production process thereof. In fact, in this tyre, each terminal zone of the carcass ply is folded back axially from the outside towards the inside around an annular insert made of hard elastomeric material, the cross-sectional profile of which is substantially wedge shaped, with a base side parallel to the bead seat of the rim.

In an area close to the vertex of the wedge, the terminal zone of the ply passes, still in an axially inwards direction, around a bead core having a substantially

circular cross-sectional profile. Soft-rubber filling elements are arranged in the areas surrounding the wedge-shaped annular insert and the bead core so that, following the tensioning produced along the extension of the carcass ply as a result of the inflation pressure, the bead core tends to be displaced axially towards the outside of the bead and consequently acts on an inclined surface of the wedge-shaped insert so as to increase the contact pressure of the bead against the bead seat of the rim.

The same Applicant has also proposed a tyre - forming the subject of European patent application No. 98.110354.2 - which has beads suitable for stable anchoring onto the corresponding seats of a rim with frustoconical bead seats directed axially outwards.

In accordance with the present invention it has been found that the processes for the manufacture of tyres with beads suitable for use on rims with frustoconical seats axially directed towards the outside may be significantly simplified if each bead of the tyre is provided with an annular reinforcing structure having preferably a cross-sectional profile substantially in the form of an "L" with a radially external branch integral with the carcass ply or plies and a radially internal branch substantially parallel to the seat of the rim and designed to act with a thrust on the latter as a result of the tension transmitted to the carcass ply or plies.

The Applicant has in fact perceived that such a tyre can be manufactured in a convenient manner by supplying the components thereof substantially in a direction radial to the axis of rotation and/or tangential with respect to

the circumferential extension of the tyre itself, substantially without axially directed movements, in accordance with the methods described in the above-mentioned European patent applications No. 97830731.2 and No. 97830733.8 as well as No. 98830472.1 in the name of the Applicant herself, hitherto not published.

In greater detail, the invention relates to a method of manufacturing a tyre for vehicle wheels, characterized in that the manufacture of the carcass structure comprises the following steps: applying, on a toroidal support shaped so as to match the internal superficial extension of said tyre, at least a first part of at least one carcass ply defining axially inner terminal zones of said at least one carcass ply; applying, radially superimposed with respect to an end portion of one or both said axially inner terminal zones, at least one circumferentially unextendable, annular, anchoring insert, having a cross-sectional profile with a flattened form extending axially away with respect to the corresponding inner terminal zone and an equatorial plane of the tyre; applying, against each inner terminal zone, at least one stiffening element having at least one main portion with a cross-sectional profile tapering away from said axis of rotation, located substantially in an axially internal position with respect to said annular anchoring insert.

It is also preferable to carry out the stage of applying at least a second part of said at least one carcass ply defining axially outer terminal zones of said at least one carcass ply.

In a preferred embodiment, application of the second

carcass ply part is performed after application of the stiffening element, so that the outer terminal zones are each superimposed on the respective stiffening element on the opposite side with respect to said inner terminal zone.

More particularly, the application of each annular anchoring insert is performed by means of winding of at least one elongated element in axially adjacent concentric turns around the toroidal support.

Preferably, an end portion of at least one of said outer terminal zones is arranged against an extended portion of the respective stiffening element, extending substantially parallel to said annular anchoring insert.

It is also advantageously envisaged carrying out the additional step of applying, radially superimposed on an end portion of at least one of said outer terminal zones, at least one circumferentially unextendable, additional, annular insert extending substantially parallel to said annular anchoring insert.

Application of the additional annular insert is conveniently carried out by means of winding at least one elongated element in axially adjacent concentric turns around the toroidal support.

In accordance with a preferred constructional solution, application of the first and/or, where present, the second part of said at least one carcass ply is performed by laying, respectively, at least one first and/or one second series of elongated sections circumferentially distributed on the toroidal support, each of said

elongated sections extending in a U-shaped configuration around the cross-sectional profile of the toroidal support, so as to define two lateral portions which are mutually spaced apart in the axial direction and support said terminal zones, and a crown portion extending in a radially external position between the lateral portions.

The sections of the first series may be advantageously laid at a circumferential pitch greater than their width, the sections of the second series each being laid with its crown portion in the space in between the two adjacent sections of the first series, so as to form together with the latter said at least one carcass ply.

In accordance with a possible constructional variant, application of the stiffening element may be carried out before application of the annular anchoring insert.

It may also be envisaged that the second part of the carcass ply is applied before application of the anchoring insert, the latter being preferably applied so as to radially superimpose an end portion of the respective outer terminal zone.

It is also preferably envisaged that, during application of the second part of said at least one carcass ply, an end portion of each outer terminal zone is arranged against an end portion of the respective inner terminal zone, extending axially away with respect to the equatorial plane.

Preferably, a step is also carried out, consisting in applying at least one circumferentially unextendable, additional, annular insert having a flattened cross-

sectional profile and extending radially against an axially inner wall of the main portion of the respective stiffening element.

More particularly, each additional annular insert is applied against one of said inner terminal zones, before application of the respective stiffening element.

Application of each additional annular insert is preferably performed by means of winding of at least one elongated element in radially adjacent concentric turns around the toroidal support.

In accordance with a further possible constructional variant, application of said at least one second part of carcass ply is carried out before application of said at least one stiffening element, so that at least one of said outer terminal zones is located between the respective inner terminal zone and the respective stiffening element.

The method according to the present invention is advantageously carried out substantially without movements directed parallel to the axis of rotation of said toroidal support and aimed at axially folding back towards said equatorial plane a terminal zone of said at least one carcass ply.

The present invention also relates to a tyre for vehicle wheels, characterized in that at least one of said annular reinforcing structures comprises: at least one stiffening element applied against said at least one carcass ply and having at least one main portion with a cross-sectional profile tapering away from a rotation

axis of the tyre; at least one circumferentially unextendable, annular, anchoring insert having a cross-sectional profile with a flattened form, extending axially away with respect to the main portion of the stiffening element.

Preferably, each annular anchoring insert extends in a direction converging towards the geometric axis of rotation of the tyre away from an equatorial plane thereof.

Advantageously, the annular anchoring insert and the stiffening element are rigidly connected together, so as to define a substantially one-piece structure formed in the manner of an "L".

The cross-sectional profile of each annular reinforcing structure conveniently has a geometric centre of gravity located in a position such that an axially outer end edge of said annular anchoring insert tends to be moved towards the axis of rotation of the tyre following a tension produced along said at least one carcass ply as a result of the inflation pressure of the tyre.

In greater detail, the cross-sectional profile of each annular reinforcing structure has a geometric centre of gravity located in a position axially external with respect to said stiffening element and axially internal with respect to an axially outer end edge of said annular anchoring insert.

Preferably, said at least one carcass ply has a first and a second part defining respectively axially inner terminal zones and axially outer terminal zones.

In a preferred constructional solution, said stiffening element is axially located between the respective axially inner terminal zone and the respective axially outer terminal zone of said at least one carcass ply.

Alternatively, the stiffening element may be applied in a position axially outside both the inner end and outer end of the carcass ply.

The annular anchoring insert may be advantageously applied, preferably in a radially external position, against an end portion of said inner terminal zone, extending axially away with respect to an equatorial plane of the tyre.

The stiffening element advantageously comprises at least one annular body made of elastomeric material preferably having a hardness greater than 48° Shore D.

Preferably, said annular anchoring insert is arranged substantially in the vicinity of a circumferentially internal edge of the main portion of the stiffening element.

Said stiffening element may have, in a radially internal position, an extended portion extending substantially parallel to said annular anchoring insert.

The presence of at least one additional annular insert extending parallel to said annular anchoring insert is also preferably envisaged.

This additional annular insert may be applied, preferably

in a radially external position, against an end portion of said outer terminal zone, extending axially away with respect to an equatorial plane of the tyre.

In a preferred constructional solution, said at least one carcass ply comprises a first and/or a second series of elongated sections circumferentially distributed, preferably in an alternate sequence, around said axis of rotation and each extending in a U-shaped configuration around the cross-sectional profile of the carcass structure so as to define two lateral portions mutually spaced in the axial direction, and a crown portion extending in a radially external position between the lateral portions.

Axially inner terminal zones and axially outer terminal zones of said carcass ply are respectively defined on the lateral portions of the sections of the first and the second series.

The annular anchoring insert may be conveniently applied in a radially external position against an end portion of said outer terminal zone, extending axially away with respect to an equatorial plane of the tyre.

The end portion of the outer terminal zone may be applied so as to be radially superimposed against an end portion of the inner terminal zone.

It is also possible to envisage at least one circumferentially unextendable, additional, annular insert having a cross-sectional profile extending radially against an axially inner wall of the main portion of said stiffening element.

The invention also relates to a tyre wheel characterized in that it comprises a mounting rim provided with bead seats defined by frustoconical surfaces converging towards the axis of rotation of the tyre, away from the equatorial plane thereof, and a tyre obtained with the method according to the invention and provided with beads designed to fit precisely into the above-mentioned seats.

The above-mentioned rim is characterized by the presence of axially internal bead-unseating safety humps with a minimum or even zero height, preferably in combination with the symmetry of its radially external profile.

This aspect of the invention is based on the recognition of the technical problem associated with passing-over of the above-mentioned hump by the bead depending on the structure of the bead itself.

It has been found that passing-over of the hump by the bead can be controlled more easily when there is a multiple-turn bead core lying in a plane substantially perpendicular to the axis of rotation and/or with turns distributed over a frustoconical surface substantially parallel to the surface of the bead seat.

It has also been found that, as a result of the use of the above-mentioned multiple-turn bead cores, it is possible to reduce significantly the depth of the well located between said bead seats on the mounting rim.

Further characteristic features and advantages will appear more clearly from the detailed description of a preferred, but not exclusive, embodiment of a method of

manufacturing a carcass structure for vehicle wheel tyres, a carcass structure which can be obtained by said method, and a wheel comprising a tyre provided with said carcass structure and assembled on a corresponding rim, in accordance with the present invention. This description will be provided hereinbelow with reference to the accompanying drawings provided only by way of example and therefore not limiting, in which:

Fig. 1 is a partial cut-away perspective view of a tyre manufactured in accordance with the present invention and mounted on a respective rim;

Fig. 2 shows a partial perspective view of an illustration of the laying sequence of a first series of elongated sections for the purpose of forming a carcass ply of the tyre according to the invention;

Fig. 3 shows a partial perspective view of an annular anchoring insert and a stiffening element applied in the vicinity of an inner terminal zone of the carcass ply, defined by the elongated sections of the first series;

Fig. 4 is a perspective view showing an additional annular insert radially superimposed on an end portion of an axially outer zone of the carcass ply, defined by second elongated sections laid in the spaces between the sections of the first series;

Fig. 5 shows a partial cross-sectional view of a tyre according to the invention mounted in an inflated condition on a respective rim;

Fig. 6 shows a tyre according to Fig. 5 in the travel condition under a lateral thrust load:

Fig. 7 shows the tyre according to Fig. 5 in the travel

condition under load and subject to lateral thrusts directed in the opposite direction to those of Fig. 6;

Fig. 8 shows a partial cross-sectional view of a tyre in accordance with a constructional variant of the invention, mounted in the inflated condition on a respective rim;

Fig. 9 shows a partial cross-sectional view of a tyre in accordance with a further constructional variant of the invention, mounted in the inflated condition on a respective rim;

Fig. 10 shows a transversely complete, partially cross-sectioned view of the tyre in accordance with the constructional variant according to Figure 8, internally provided with an inner tube and mounted in the inflated condition on a respective rim.

With reference to the figures mentioned, 1 denotes in its entirety a tyre for vehicle wheels which can be obtained by means of a method according to the present invention.

The tyre 1 has a carcass structure 2 comprising at least one carcass ply 3 formed in a substantially toroidal configuration and engaged, by means of its terminal zones 15, 16, with a pair of annular, axially spaced, reinforcing structures 4 (only one of which is shown in the drawings), each of said structures, when the tyre is complete, being located in the area usually identified by the term "bead".

A belt structure 5 comprising one or more belt layers 6a, 6b and 7 is applied onto the carcass structure 2 in a circumferentially external position. A tread band 8 is circumferentially superimposed on the belt structure 5,

said tread band having formed in it, following a moulding operation performed at the same time as vulcanization of the tyre, longitudinal and transverse recesses 8a which are arranged so as to define a desired "tread pattern".

The tyre also comprises a pair of so-called "sidewalls" 9 which are applied laterally on opposite sides onto the carcass structure 2.

The carcass structure 2 may also be lined along its internal walls by a sealing layer 10 or so-called "liner", essentially consisting of a layer of elastomeric material which is airtight and designed to ensure hermetic sealing of the tyre itself once inflated.

Assembly of the above-mentioned components, as well as the manufacture of one or more of them, is performed with the aid of a toroidal support 11 which can be seen in schematic form in Figures 2 to 4 and which is formed in accordance with the configuration of the internal walls of the tyre to be formed. In particular, this toroidal support 11 has, in a radially internal position, two axial protrusions defining frustoconical support surfaces 11a converging towards the axis of rotation of the tyre away from the equatorial plane X-X thereof, at an angle roughly equal to 15° and preferably ranging between 10° and 20°, even though values outside the specific range are possible.

The toroidal support 11 may have dimensions which are smaller than those of the finished tyre, in accordance with a linear measurement preferably of between 2% and 5% taken, for example, along the circumferential extension of the support itself in an equatorial plane X-X thereof

which coincides with the equatorial plane of the tyre itself.

The toroidal support 11, which is neither described nor illustrated in detail since it is not particularly relevant for the purposes of the invention, may for example consist of a collapsible drum or an inflatable chamber which is suitably reinforced so as to assume and maintain the desired toroidal configuration in the inflated condition.

All this having been stated, manufacture of the tyre 1 envisages first of all the formation of the carcass structure 2, which starts with the formation, if appropriate, of the sealing layer 10.

This sealing layer 10 may be advantageously made by means of the circumferential winding, around the toroidal support 11, of at least one ribbon-like band 12 of airtight elastomeric material which is produced by means of an extruder and/or a calender which are arranged in the vicinity of the toroidal support itself. As can be understood from Figure 1, winding of the ribbon-like band 12 is performed substantially in circumferential turns consecutively arranged alongside each other so as to follow the cross-sectional profile of the external surface of the toroidal support 11.

For the purposes of the present description, cross-sectional profile is understood as being the configuration represented by the semi-section of the toroidal support 11 sectioned along a plane radial to a geometric axis of rotation thereof - not shown in the drawings - coinciding with the geometric axis of rotation

of the tyre and hence of the carcass structure 2 being formed.

In accordance with the present invention, the carcass ply 3 is formed directly on the toroidal support 11 by laying, as will be clarified more fully below, a first and a second series of elongated sections 13, 14 obtained from at least one continuous elongated element having preferably a width of between 3 mm and 15 mm. This elongated element basically comprises one or more filament-like elements, preferably 3 to 10 filament-like elements which are arranged alongside each other in a longitudinal and parallel manner and are at least partially incorporated in a layer of elastomeric material.

These filament-like elements may, for example, each consist of a textile cord having preferably a diameter of between 0.6 mm and 1.2 mm or a metal cord having preferably a diameter of between 0.3 mm and 2.1 mm. The continuous elongated element, which is supplied, for example, directly from an extruder intended for the manufacture thereof, may advantageously be guided on a laying apparatus, the structural and functional characteristics of which are described in more detail in European patent application No. 97830731.2 in the name of the same Applicant, the contents of which are considered hereinbelow.

This laying apparatus is suitable for cutting sequentially the continuous elongated element so as to form the elongated sections 13, 14 of predetermined length.

The cutting of each elongated section 13, 14 is immediately followed by the laying thereof onto the toroidal support 11 forming, for example with the aid of movable gripping elements and/or suitable rolling members, the elongated section in a U-shaped configuration around the cross-sectional profile of the toroidal support itself. Once laying has been performed, each elongated section 13, 14 essentially comprises two lateral portions 13a, 14a extending radially towards the axis of the toroidal support 11, in positions axially spaced from one another, and a crown portion 13b, 14b extending in a radially external position between the lateral portions themselves. It must be pointed out that each lateral portion 13a, 14a follows exactly the surface of the toroidal support 11 as far as a point close to the axially outer edges of the respective frustoconical support surface 11a.

The toroidal support 11 may be angularly rotated so as to perform a step-by-step movement in synchronism with operation of the above-mentioned laying apparatus, so that each action involving cutting of each elongated section 13, 14 is followed by laying thereof in a position circumferentially spaced with respect to the previously laid down section 13, 14.

More particularly, the rotation of the toroidal drum 11 occurs preferably with an angular pitch corresponding to a circumferential displacement equal to a multiple of the width of each elongated section 13, 14, more precisely twice said width.

It must be pointed out for the purposes of the present description, where not otherwise indicated, that the term

"circumferential" refers to a circumference lying in the equatorial plane X-X and in the vicinity of the external surface of the toroidal support 11.

According to a preferred embodiment of the present invention, the operating sequence described above is such that a first complete revolution of the toroidal support 11 about its axis results in the formation of a first part of the carcass ply 3 following the laying of the first series of elongated sections 13 circumferentially distributed with a circumferential spacing equal to twice the width of each of the said sections.

This first part of the carcass ply 3 comprises, in radially internal areas of the lateral portions 13a, axially inner terminal zones 15 which are mutually spaced (only one being visible in the drawings) and each of which is extended by an end portion 17 which is folded axially back outwards, i.e. away from the equatorial plane X-X, preferably in a direction parallel to the frustoconical support surface 11a.

As can be clearly seen from Figure 2, an empty space S is preferably left between two sections of the first series, said space, at least in the crown portion 13b of the sections themselves, having a width equal to that of the said sections.

For the purposes of the present invention, however, it is also possible for the movement of the toroidal support 11 to be performed with a circumferential interval equal to the width of each of the sections themselves, so that the sections of the first series are laid with the respective crown portions 13b in a mutually adjacent relationship so

as to result in the formation of a first complete carcass ply.

Preferably the laying of each elongated section 13 of the first series is performed in a plane parallel to the axis of rotation of the toroidal support 11. However, it is possible to envisage, if necessary, that laying of the elongated sections 13 may be performed with an orientation inclined relative to the direction of circumferential extension of the toroidal support 11, for example at an angle of between 15 and 35 degrees.

Adjustment of the angle of laying of the elongated sections 13, 14 may be obtained, for example, by suitably orienting the geometric axis of rotation of the toroidal support 11 with respect to the above-mentioned laying apparatus.

The formation of a carcass structure 2 then proceeds with the step of applying the above-mentioned unextendable annular structures 4, or at least some of them, in the vicinity of each of the inner terminal zones 15 of the carcass ply 3 being formed, so as to obtain the carcass areas, known as "beads" which are specially designed to ensure fixing of the tyre onto a corresponding mounting rim.

In accordance with the present invention, one, or preferably, both the annular reinforcing structures 4 are advantageously formed in accordance with the description given in co-pending European patent application No. 98110354.2 in the name of the same Applicant.

More particularly, in the constructional solution

according to Figs. 1 to 7, the formation of each annular structure 4 envisages firstly the step of forming, radially superimposed with respect to the end portion 17 of each inner terminal zone 15, at least one circumferentially unextendable annular anchoring insert 19 having a cross-sectional profile with a flattened form and extending substantially axially away from the equatorial plane X-X.

More particularly, it is preferably envisaged that the cross-sectional profile of the annular anchoring insert 19 extends in a direction converging towards the geometric axis of the toroidal support away from the equatorial plane X-X, at an angle preferably equal to 15° and in any case corresponding to the inclination present on the corresponding frustoconical support surface 11a.

More particularly, in accordance with a preferred constructional solution, the annular anchoring insert 19 is formed directly against the inner terminal zone 15 of the carcass ply part 3 defined by the elongated sections 13 of the first series, by means of winding of at least one continuous filament-like element in axially adjacent concentric turns 19a around the toroidal support 11.

The turns 19a forming the annular anchoring insert 19 may be arranged in one or more radially superimposed layers, with the aid, if necessary, of rollers or other suitable means acting against the surface of the toroidal support 11.

The sticky consistency of the elastomeric layer which lines the elongated sections 13 of the first series, and, if present, the sealing layer 10 laid beforehand on the

drum itself, ensure the stable positioning of the individual turns 19a during forming.

The laying of the filament-like element may be advantageously preceded by a rubberization step during which the filament-like element itself, which is preferably made of metallic material, is lined with at least one layer of raw elastomeric material which, in addition to ensuring an excellent rubber-metal bond on the filament-like element itself, facilitates adhesion thereof for the purposes of stable positioning on the carcass structure being formed.

At least one stiffening element 20 is then formed against each inner terminal zone 15 of the first portion of the carcass ply 3, said stiffening element having a main portion 21 with a substantially triangular cross-sectional profile tapering away from the axis of rotation of the tyre and arranged substantially in an axially internal position with respect to the annular anchoring insert 19.

The stiffening insert 20, comprising preferably an annular body made of elastomeric material with a hardness greater than 48° Shore D and preferably ranging between 48° and 55° Shore D, may be advantageously formed directly against the inner terminal zone 15, for example by applying a continuous strip of elastomeric material emerging from an extruder located adjacent to the toroidal support 11.

Said continuous strip may have the definitive cross-sectional form of the stiffening element 20 already when it emerges from the extruder. Alternatively, the

continuous strip will have a cross-section which is smaller than that of the stiffening element 20, and the latter will be obtained by applying the strip itself in several adjacent and/or superimposed turns, so as to define the final configuration of the stiffening element 20.

In the constructional solution according to Figures 1 to 7, moreover, it is envisaged that the stiffening element 20 should have, in a radially internal position, an extended portion 22 forming a continuation of the main portion 21, in a direction substantially parallel and radially superimposed with respect to the annular anchoring insert 19.

In accordance with a preferred constructional solution of the invention, after application of the stiffening element 20, the formation of the first carcass ply 3 is terminated by means of the laying of the second series of elongated sections 14 obtained by cutting to size the above-mentioned continuous elongated element and applied onto the toroidal support 11 in a manner similar to that described for the elongated sections 13 of the first series.

As can be clearly seen from Figure 4, each section 14 of the second series is laid in a U-shaped configuration around the cross-sectional profile of the toroidal support 11, between two consecutive sections 13 of the first series and in a direction parallel to the latter. More particularly, each section 14 of the second series has its respective crown portion 14b circumferentially arranged in between the crown portions 13b of the sections 13 of the first series, so as to fill the space

S existing between them, and a pair of axially spaced lateral portions 14a.

Overall, the elongated sections 14 of the second series define a second part of the carcass ply 3, having axially outer terminal zones 16, each of which is located in an axially external position with respect to the respective inner terminal zone 15. More particularly, in the examples according to Figures 7 to 8, each outer terminal zone 16 is superimposed in an axially external position on the main portion 21 of the respective stiffening element 20 and is extended by an end portion 18 extending axially away with respect to the equatorial plane X-X, being radially superimposed on the extended portion 22 of the stiffening element itself.

Consequently, each stiffening element 20 is axially located between the axially inner terminal zone 15 and the axially outer terminal zone 16 of the carcass ply 3.

It may also be envisaged that the lateral portions 14a of each section 14 of the second series partially cover the lateral portions 13a of two consecutive sections 13 of the first series, each along a section comprised between the radially outer edge of the respective stiffening element 20 and the transition zone between the lateral portion itself and the crown portion 13b, 14b.

Owing to the mutual convergence between the adjacent lateral portions 13a, 14a oriented radially with respect to the geometric axis of the toroidal support 11, the overlapping or covering of the lateral portions 13a of the sections 13 of the first series, namely the circumferential width of the overlapping zones,

progressively decreases from a maximum value in the vicinity of the radially outer edge of the stiffening element 20 of each annular reinforcing structure 4 to a zero value in the transition zone between the lateral portions 13a, 14a and the crown portions 13b, 14b.

In accordance with a possible variant embodiment, which may be adopted in particular in the case where the sections 13 of the first series are laid so as to form a first complete carcass ply, any sections 14 of the second series may also be laid at a circumferential interval equal to their width, so as to be adjacent to one another and define together a second carcass ply superimposed on the first carcass ply. In this case, the sections 14 of the second series may be obliquely oriented with respect to the direction of circumferential extension of the tyre, preferably in the opposite direction with respect to any inclination of the sections 13 of the first series.

In accordance with the constructional solution according to Figures 1 to 7, after the elongated sections 14 of the second series have been laid, the forming of the annular bead reinforcing structures 4 is completed.

For this purpose, as can be seen from Figure 4, for each of the annular reinforcing structures 4, a circumferentially unextendable, additional, annular insert 23, with a flattened cross-sectional profile substantially parallel to the annular anchoring insert 19, is applied. Preferably this additional annular insert 23 is directly formed in a radially external position against the end portion 18 of the outer terminal zone 16, by means of winding of a respective filament-like element

in axially adjacent concentric turns 23a around the toroidal support 11.

Following this operation, the end portion 18 of each outer terminal zone 16 remains advantageously enclosed between the extended portion 22 of the stiffening element 20 and the additional annular insert 23.

In tyres of the radial type, a belt structure 5 is usually applied to the carcass structure 2.

This belt structure 5 may be formed in any manner convenient for the person skilled in the art and, in the example illustrated, comprises essentially a first and a second belt layer 6a, 6b having cords with a respectively intersecting orientation. An additional belt layer 7, is superimposed on said belt layers for example obtained by winding at least one continuous cord in axially adjacent turns onto the first and second belt layers 6a, 6b

The tread band 8 and the side walls 9, which may also be obtained in any manner convenient for the person skilled in the art, are then applied onto the carcass structure 2. Constructional examples of a belt structure, of sidewalls and of a tread band which may be advantageously used for the complete formation of the tyre 1 on the toroidal support 11 are described in European patent No. 97830632.2 in the name of the same Applicant.

The tyre 1 thus prepared is now ready to undergo - after removal, where appropriate, from the support 11 - a vulcanization step which may be carried out in any convenient manner.

The constructional variant illustrated in Fig. 8 differs from that described above in the way in which the annular reinforcing structures 4 are formed. It is in fact envisaged that the additional annular insert 23 of each annular reinforcing structure 4, where present, is substantially oriented radially with respect to the axis of the tyre and applied against an axially internal wall of the main portion 21 of the respective stiffening element 20.

More particularly, it is preferably envisaged that each additional annular insert 23 is directly formed against the respective inner terminal zone 15, prior to application of the stiffening element 20, by winding the respective filament-like element so as to form the mutually adjacent concentric turns 23a in a radially superimposed relationship around the toroidal support 11.

It must be pointed out that such an additional annular insert may also be used in the constructional solution described with reference to Figures 1 to 7, in addition to or by way of replacement of the additional annular insert 23 illustrated in these figures.

After formation of the additional annular insert 23, the stiffening element is formed in a manner similar to that described with reference to the constructional solution according to Figures 1 to 7.

Preferably, in the variant embodiment according to Fig. 8, the stiffening element 20 does not have the extended portion 22. In this case, during subsequent laying of the elongated sections 14 of the second series, the end portions 18 of the outer terminal zones 16 are each

arranged against the end portion 17 of the respective inner terminal zone 15, in a radially superimposed relationship against the latter.

The formation of each annular reinforcing structure 4 is completed with the application of the annular anchoring insert 19, which is formed radially superimposed on the end portion 18 of the respective outer terminal zone 16, by means of winding of the respective filament-like element so as to form axially adjacent concentric turns 19a. In contrast to that stated above, in the embodiment variant according to Figure 9 it is envisaged that the stiffening element 20 is located in an axially external position with respect to the whole carcass ply 3. For this purpose, the application, where necessary, of the strip-shaped sections 14 of the second series for formation of the second part of the carcass ply 3 is performed prior to application of the stiffening element 20 as well as any additional annular insert 23. In this way each outer terminal zone 16 is located in between the respective inner terminal zone 15 and the stiffening element 20 itself.

As regards the remaining structural and constructional aspects of the constructional solution according to Figure 9, reference should be made to the description already given in connection with Figure 8.

In each of the constructional solutions described, the mutual interaction between the annular anchoring insert 19, the stiffening element 20 and the remaining components of the carcass structure 2 is such that the stiffening element and the annular anchoring insert are substantially connected rigidly to one another.

In other words, the annular anchoring insert 19 and the stiffening element 20 act, from a functional point of view, in the manner of a one-piece structure which is substantially L-shaped and has a radial arm consisting of the main portion 21 of the stiffening element 20, and an axial arm consisting of the annular anchoring insert 19 extending axially away with respect to the equatorial plane X-X of the tyre.

Figures 5 to 9 illustrate in schematic form the functional behaviour of the tyre 1. In these figures the tyre 1 is shown mounted on a respective rim 30 provided, in axially opposite positions, with two seats 31 for engagement of the beads. Each engaging seat 31 has a so-called bead seat 31a defined by a frustoconical surface converging towards the axis of the tyre away from the equatorial plane X-X, parallel to the extension of the respective anchoring insert 19. The seat 31a is axially delimited between an axially external circumferential hump 31b and an axially internal circumferential hump 31c, referred to below also as a "bead unseating safety hump".

As indicated in the above-mentioned figures, the cross-sectional profile of the annular reinforcing structure 4 has its geometric centre of gravity G located in an axially external position with respect to the stiffening element 20 and an axially internal position with respect to the axially external terminal edge of the annular anchoring insert 19.

The inflation pressure of the tyre produces a tensioning effect on the carcass ply along the filament-like

elements incorporated in the sections of the first and second series.

In Figure 5, relating to the tyre in the inflated condition, the tensioning effect of the sections 13 of the first series is produced by the force T applied in the vicinity of the radially internal edge of the stiffening element 20. The force T, which is tangential to the longitudinal extension of the respective section 13 in the application point indicated above, has a value proportional to the value of the inflation pressure and to the value of the radius of curvature R presented by the cross-sectional profile of the carcass ply 3 in the vicinity of the side wall of the tyre 9 and produces around the centre of gravity G a moment M as a result of which the anchoring insert 19 is pushed in the vicinity of its axially external edge against the seat 31a of the respective rim 30. A perfect hermetic seal of the air contained inside the tyre is thus ensured as a result of the thrust P exerted by the bead against the seat 31a of the rim 30.

Fig. 6 shows the tyre in travel conditions under load and subject to lateral thrust. More particularly, Fig. 6 illustrates the behaviour of the tyre in the region of the bead located on the inner side of a bend negotiated by the vehicle.

As can be noted, as a result of the lateral thrust effect F, the carcass structure undergoes compression and lateral displacement with respect to the equatorial plane X-X, towards the inside of the bend.

Consequently, the radius of curvature of the carcass ply

3 in the vicinity of the side wall is reduced to a value R' less than the radius R which can be measured in the conditions according to Fig. 5. At the same time, the bead 4 of the tyre, particularly in the vicinity of the main portion 21 of the stiffening element 20, undergoes flexing which tends to increase tensioning of the axially inner zone 15 of the carcass ply 3, which has the effect of producing a further increase in the moment M and consequent thrust P' exerted by the axially outer zone of the bead against the seat 31a.

Figure 7 shows the tyre in travel conditions under lateral thrust load, with regard to the bead arranged on the outer side of a bend negotiated by the vehicle. In this situation, the compression and lateral displacement effect induced on the carcass structure 3 causes the latter to assume, in the region of the sidewall 9, a curved extension having a radius R" which is wider than the radius R which can be found in the condition described in Figure 5.

Tensioning of the carcass ply 3 is consequently increased in both the inner terminal zone 15 and outer terminal zone 16, and the main portion 21 of the stiffening element 20 tends to flex towards the equatorial plane X-X. In this situation the bead of the tyre tends to exert an axial thrust P" directed towards the external circumferential hump 31c, increasing the contact pressure on the seat 31b owing to the conicity of the latter and the annular anchoring insert 19.

Figure 10 shows a partially cross-sectioned view of the tyre according to the invention mounted on a rim provided with bead seats defined by frustoconical surfaces

converging towards the axis of rotation of the tyre, away from the equatorial plane thereof, at an angle β preferably ranging between 5° and 25°, and even more preferably equal to 20°.

The bead of the tyre incorporates a circumferentially unextendable annular reinforcing structure chosen from among those described above, in particular that described with reference to Figure 8.

The rim has a preferably symmetrical radially external profile which comprises a wide central well axially delimited by said bead seats having a minimum diameter D_m greater than the minimum diameter D_r of said well.

In the region of each bead seat, the rim has a hump 31c in an axially internal position designed to prevent the corresponding bead of the tyre during travel from passing over it and thus dropping inside the central well.

Known tyres, which are mounted on rims with bead seats formed as described - for example, the tyre according to patent US 5,634,993 already mentioned - are provided with beads reinforced with the usual bead cores according to the state of the art, consisting of a single metal core, referred to hereinbelow as a "one-piece bead wire" to distinguish it from the "multiple-turn" bead wires of the bead reinforcing structure according to the invention.

It was realized that, with these tyres, the above-mentioned hump must have a considerable radial extension so as to prevent, in the case of deflation of the tyre, the bead from passing over the hump and having well-known serious consequences on the road-holding performance of

the vehicle. In other words, the diameter of the hump must be at least substantially equal to the maximum diameter of the one-piece bead wire. For this reason known rims have a central well which is greatly depressed with respect to the diameter of the bead seat measured in a position adjacent to the hump: in this way, in fact, during fitting of the tyre onto the rim, the bead of the tyre may be arranged in a very eccentric position with respect to the rim so as to be able to pass over the hump, axially from the inside towards the outside, in successive stages, firstly along a circumferential centre line of the hump and then along the diametrically opposite circumferential centre line.

With tyres of the type illustrated in the US patent cited above, the problem is particularly serious owing to the fact that the radially more internal diameter of the tyre bead, equal to D_m, is much smaller than the maximum diameter D_c of the bead seat, i.e. the tyre fitting diameter. Consequently the depth of the above-mentioned well must be made much larger and this creates problems with regard to mounting the wheel onto the hub of the vehicle.

The said patent solves the problem by using a rim with varied fitting, i.e. by increasing the diameter of the bead seat on the vehicle side so as to be able to increase the minimum diameter of the well in the axially adjacent portion. This measure is able to solve the problem of mounting the wheel on the vehicle, but gives rise to a series of problems in connection with the road-handling performance of the tyre, due to the fact that the corresponding tyre is a tyre with an asymmetrical structure, i.e. having beads with different fitting

diameters, and therefore reacts in a non-uniform manner to the stresses affecting it.

The tyre according to the invention solves this problem too in an effective manner.

It must first of all be noted that the pair of bead cores each consisting of a winding of several turns of metal cord forms a bead reinforcing structure which is much more flexible than the known one-piece bead wire and is capable therefore, when the tyre is deflated, of being deformed more easily so as to assume the particular elliptical (oval) configuration necessary for allowing the bead to pass over the axially internal hump of the rim during the operation of mounting the tyre onto the rim and, conversely, removal thereof from the rim.

It must be noted, moreover, that these windings, which may also be used separately from one another - i.e. individually - in the specific embodiment shown, are used in combination with one another, and more specifically one being arranged in a plane substantially perpendicular to the axis of rotation of the tyre, and the other being arranged along a frustoconical surface substantially parallel to the bead seat; consequently, this structure behaves substantially in the manner of a rigid L-shaped reinforcement, as described above.

Therefore, when the tyre is mounted on the rim, this reinforcement is much more resistant to the forces which are directed axially towards the inside and which, in the case of beads with a one-piece bead core, are able to cause the bead to slip over the hump.

In these known tyres, in fact, when the bead core has managed to pass over the hump, no other structural element of the bead is able to prevent bead unseating. Whereas, in the tyre according to the invention, in each of the windings referred to above, the increase in the diameter needed for bead unseating to occur would result in a progressively greater increase in the diameter of the turns of said windings, and, in particular in the radial winding, an increasing elongation from the radially innermost turn to the turn in the radially outermost position. Such elongation is effectively prevented by the mechanical strength characteristics of the cord used.

Also, in the case of a conical winding, bead unseating would require a gradual increase in the diameter of the cord turns, i.e. an increasing elongation of the winding turns, from the turn in the axially innermost position to the turn in the axially outermost position. Such increases are effectively prevented by the substantial unextendable nature of the cord used.

By way of conclusion, the hump could also not be present, the bead seat per se forming a hump which is sufficient to prevent bead unseating and, in any case, the height of the hump may be kept to within very small values and also the depth of the channel may have a small value.

It will now be obvious that the problem may also be resolved using a single winding of metal turns, preferably arranged along a frustoconical surface parallel to the surface of the bead seat.

In particular, it is preferable to keep the diameter D_h

of the hump 31c so that it has a value which is not less than the radially external diameter of the axially innermost cord turn of the conical winding. In combination, or by way of an alternative, it is preferable to keep the diameter D_h of the hump 31c at a value which is not greater than the radially external diameter of the radially innermost cord turn of the radial winding.

With reference to Figure 10 which shows a tyre of size 215/630/420, the fitting diameter D_c is equal to 424.2 mm, the height h of the hump is equal to 3.5 mm, and in any case is not greater than 4 mm and is preferably between 3 and 4 mm, and the depth h_c of the central well is 17.5 mm, preferably between 15 and 25 mm.

In a preferred embodiment of the invention, illustrated in Figure 10, the wheel formed by the assembly of the tyre and rim described above also comprises a device which is designed to provide the wheel with a self-supporting capacity also in partially deflated conditions. Preferably, the above-mentioned device consists of an inner tube 100, with separate cavities, even more preferably the inner tube described in the already mentioned patent application EP 98.110354.2 in the name of the same Applicant.

The above-mentioned inner tube, which is elastically expandable by means of the introduction of pressurized fluid into its internal volume, has an elliptical shape so as to adapt itself in particular to low-profile tyres and comprises two separate and independent volumes which can be inflated separately from one another and are separated by a central longitudinal wall 105 having a

high rigidity and extending in a plane perpendicular to the axis of rotation of the wheel.

Inflation of the above-mentioned chambers is preferably controlled by means of the valves without a fixed connection to the mounting rim, which are described in the preceding patent application No. EP 98.830074.4 in the name of the same Applicants. Preferably, each of these valves 110 performs, separately from each other, the three functions of inflation, rapid deflation and calibration of the correct value for the inflation pressure.

The present invention achieves important advantages.

In particular, as a result of the constructional design of the annular reinforcing structures 4 according to the invention, it is possible to obtain a tyre which is suitable for mounting on a rim provided with bead seats having a conicity directed towards the outside, without resulting in any substantial complication in the tyre manufacturing process.

As a result of the invention, in fact, it is possible to make use of the tension produced on the carcass ply or plies so as to obtain an increase in the contact pressure of the bead on the seat of the rim in any operating condition, without requiring for this purpose the provision of complex annular reinforcing structures envisaged by the known art.

In particular, as a result of the simplified annular reinforcing structures according to the invention, it is possible to assemble components of the whole tyre on a

rigid drum having the internal shape of the tyre itself, in a completely automatic manner.

In fact, in accordance with the above description, the tyre is preferably manufactured by applying onto a collapsible rigid annular support the constituent elements of the tyre, and in particular of the bead reinforcing structures, with movements directed substantially perpendicularly with respect to the axis of rotation of the support itself and/or tangentially with respect to its circumferential extension. More particularly, the invention offers the possibility of supplying the components substantially without movements directed parallel to said axis of rotation, or in any case such as to cause axial folding back, towards the inside, of terminal zones of the carcass ply or plies.

More specifically, as a result of the invention, it is possible to manufacture tyres which are suitable for mounting on rims of the above-mentioned type, using the new constructional ideas developed by the same Applicant and forming the subject of the already cited co-pending European patent applications Nos. 97830731.2, 97830733.8 and 98830472.1 and therefore exploit all the advantageous aspects thereof in relation to the known manufacturing processes.

It must be pointed out, in fact, that, as a result of the constructional and structural design of the tyre in question, especially with reference to its carcass structure 2, it is possible to achieve notable improvements in terms of structural strength - in particular in the vicinity of the beads, where a greater structural strength is normally required - as well as in

terms of performance, in particular with regard to the effects of lateral thrust which occur during travel around bends.

In this context, a further advantage offered by the tyres according to the invention, substantially arising from the replacement of the traditional one-piece bead core with the new multiple-turn bead cores, is that of allowing the use of mounting rims of the type mentioned, with symmetrical bead seats, i.e. with the same fitting diameter, in combination with a central well having a minimum depth, and preferably without axially internal bead-unseating safety humps, or with humps having a minimum depth. In particular, the constructional characteristics of the annular reinforcing structures and the methods with which they are integrated into the carcass ply are such as to increase further the structural strength of the tyre 1 in the zones of the beads and the side walls.

In fact, the presence of the circumferentially unextendable annular inserts 19, 23 intimately joined to the carcass ply or carcass plies 3 provides an excellent "bond" with the filament-like elements of the various series of elongated sections 13, 14. The carcass structure 2 is thus strengthened in the zones corresponding to the beads of the tyre 1 without requiring for this purpose the use of additional elongated inserts, usually called "flippers", which are looped back around the annular reinforcing structures 4 and which are used instead in the known art.

In particular, the elimination of the axial backfolds of the terminal zones of the carcass ply, with the

consequent elimination of the movements coaxial with the toroidal support and the devices designed to perform the corresponding process steps, has made the tyre manufacturing process simpler, faster and more economical and has also made it possible to eliminate, from the tyre structure, an element of discontinuity which has been the cause of significant problems in the vulcanized tyre and during operation.

CLAIMS

1. A method of manufacturing a tyre for vehicle wheels, comprising the steps of:
- making a carcass structure (2) having at least one carcass ply (3) provided with terminal zones in engagement with respective annular reinforcing structures (4) axially spaced apart from each other;
- applying a belt structure (5) to the carcass structure (2) at a circumferentially outer position thereof;
- applying a tread band (8) to the belt structure (5) at a circumferentially outer position thereof and at least one pair of sidewalls (9) at laterally opposite positions on the carcass structure (2),
characterized in that manufacture of the carcass structure (2) comprises the following steps:
- applying at least one first part of said at least one carcass ply (3) on a toroidal support (22) the shape of which matches that of the inner surface extension of said tyre, which part defines axially inner terminal zones (15) of said at least one carcass ply (3);
- applying at least one circumferentially inextensible annular anchoring insert (19) in radial superposition relationship with an end portion (17) of at least one of said axially inner terminal zones (15), which insert (19) has a cross-section profile of flattened conformation extending axially away from the corresponding inner terminal zone (15) and from an equatorial plane (X-X) of the tyre;
- applying at least one stiffening element (20) against at least one of said inner terminal zone (15), which stiffening element (20) has at least one primary portion (21) with a cross-section profile tapering away from said rotation axis which is located substantially at an axially inner position

relative to said annular anchoring insert (19).

2. A method as claimed in claim 1, further comprising the step of carrying out application of at least one second part of said at least one carcass ply (3) defining axially outer terminal zones (16) of said at least one carcass ply (3), placed at an axially outer position relative to said inner terminal zones (15).

3. A method as claimed in claim 2, wherein application of said at least one second part of carcass ply (3) is carried out after application of said at least one stiffening element (20), so that at least one of said outer terminal zones (16) is superposed on the respective stiffening element (20) on the opposite side relative to said inner terminal zone (15).

4. A method as claimed in claim 1, wherein application of said annular anchoring insert (19) takes place by winding up at least one thread-like element in concentric coils (19a) disposed axially in side by side relationship around the toroidal support (11).

5. A method as claimed in claim 2, wherein an end portion (18) of at least one of said outer terminal zones (16) is disposed against an extension portion (22) of the respective stiffening element (20), substantially extending parallelly of said annular anchoring insert (19).

6. A method as claimed in claim 2, further comprising the step of applying at least one additional circumferentially-inextensible annular insert (23) in radial superposition relationship with an end portion (18) of at least one of said outer terminal zones (16), which additional insert substantially extends

parallelly of said annular anchoring insert (19).

7. A method as claimed in claim 6, wherein application of said additional annular insert (23) takes place by winding up at least one thread-like element in concentric coils (23a) disposed axially in side by side relationship around the toroidal support (11).

8. A method as claimed in claim 1, wherein application of said at least one first part of said at least one carcass ply (3) is carried out by laying down at least one first series of elongated sections (13), which are circumferentially distributed on the toroidal support (11), each of said elongated sections (13) extending in a U-shaped configuration around the cross-section profile of the toroidal support (11), to define two side portions (13a) mutually spaced apart in an axial direction and carrying said inner terminal zones (15), and a crown portion (13b) extending at a radially outer position between the side portions (13a).

9. A method as claimed in claim 2, wherein application of said at least one second part of said at least one carcass ply (3) is carried out by laying down at least one second series of elongated sections (14) circumferentially distributed on the toroidal support (11), each of said elongated sections (14) extending in a U-shaped configuration around the cross section profile of the toroidal support (11), to define two side portions (14a) mutually spaced apart in an axial direction and carrying said outer terminal zones (16), and a crown portion (14b) extending at a radially outer position between the side portions (14a).

10. A method as claimed in claims 8 and 9, wherein the sections of the first series (13) are laid down at a circumferential pitch greater than their width, the sections of the second series (14) being each laid down with their crown portion (14b) in the space existing between two contiguous sections of the first series (13), to form said at least one carcass ply (3) together with the last mentioned sections.

11. A method as claimed in claim 1, wherein application of the stiffening element (20) is carried out before application of the annular anchoring insert (19).

12. A method as claimed in claim 2, wherein application of said at least one second part of the carcass ply (3) is carried out before application of said at least one anchoring insert (19).

13. A method as claimed in claim 12, wherein said at least one anchoring insert (19) is applied in radial superposed relationship with an end portion (18) of the respective outer terminal zone (16).

14. A method as claimed in claim 12, wherein during application of the second part of said at least one carcass ply (3), one end portion (18) of each outer terminal zone (16) is disposed against an end portion (17) of the respective inner terminal zone (15), extending axially away from the equatorial plane (X-X).

15. A method as claimed in claim 1, further comprising the step of applying at least one additional circumferentially-inextensible annular insert (23) having a flattened cross-section profile radially extending against an axially inner wall of the

primary portion (21) of said at least one stiffening element (20).

16. A method as claimed in claim 15, wherein each additional annular insert (23) is applied against one of said inner terminal zones (15), before application of the respective stiffening element (20).

17. A method as claimed in claim 15, wherein application of each additional annular insert (23) takes place by winding up at least one thread-like element in concentric coils (23a) disposed radially in side by side relationship around the toroidal support (11).

18. A method as claimed in claim 2, wherein application of said at least one second part of the carcass ply (3) is carried out before application of said at least one stiffening element (20), so that at least one of said outer terminal zones (16) is interposed between the respective inner terminal zone (15) and the respective stiffening element (20).

19. A method of manufacturing a tyre for vehicle wheels, in particular as claimed in claim 1, characterized in that accomplishment of the carcass structure (2) comprises the following steps:
- sequentially laying down a plurality of elongated sections (13) adapted to form at least one first part of said at least one carcass ply (3), in a circumferential direction on a toroidal support (11) the shape of which matches that of the inner surface extension of said tyre, which first part defines axially inner terminal zones (15) of said at least one carcass ply (3);
- winding up at least one circumferentially-inextensible annular anchoring insert (19) in a

circumferential direction relative to said toroidal support (11) and in radial superposed relationship with an end portion (17) of each of said axially inner terminal zones (15), which insert (19) has a cross section profile of flattened conformation extending axially away relative to the corresponding inner terminal zone (15) and to an equatorial plane (X-X) of the tyre;

- laying down at least one stiffening element (20) in a circumferential direction relative to said toroidal support (11) against each inner terminal zone (15), which element (20) has at least one primary portion (21) with a cross section profile tapering away from said rotation axis and substantially disposed at an axially inner position relative to said annular anchoring insert (19);

- sequentially laying down a plurality of elongated sections (14) adapted to form at least one second part of said at least one carcass ply (3), in a circumferential direction on said toroidal support (11), which second part defines axially outer terminal zones (16) of said at least one carcass ply (3), each superposed on the respective stiffening element (20) on the opposite side relative to said inner terminal zone (15).

20 A method as claimed in claim 1, characterized in that it is put into practice substantially in the absence of movements directed parallelly of the rotation axis of said toroidal support (11) and aiming at axially turning up an end portion (15, 16) of said at least one carcass ply (3) towards said equatorial plane (X-X).

21. A tyre for vehicle wheels, comprising:

- a carcass structure (2) having at least one carcass

ply (3) provided with terminal zones (15, 16) in engagement with respective annular reinforcing structures (4) axially spaced apart from each other;
- a belt structure (5) applied to the carcass structure (2) at a circumferentially outer position thereof;
- a tread band (8) applied to the belt structure (5) at a circumferentially outer position thereof;
- at least one pair of sidewalls (9) applied to the carcass structure (2) at laterally opposite positions;
characterized in that at least one of said annular reinforcing structures (4) comprises:
- at least one stiffening element (20) applied against said at least one carcass ply (3) and having at least one primary portion (21) having a cross-section profile tapering away from a rotation axis of the tyre;
- at least one circumferentially-inextensible annular anchoring insert (19) having a cross-section profile of flattened conformation, extending axially away from the primary portion (21) of the stiffening element (20).

22. A tyre as claimed in claim 21, wherein each annular anchoring insert (19) extends in a direction converging towards the geometric rotation axis of the tyre away from an equatorial plane (X-X) of the same.

23. A tyre as claimed in claim 21, wherein said annular anchoring insert (19) and said stiffening element (20) are substantially rigidly connected with each other.

24. A tyre as claimed in claim 21, wherein the cross section profile of each annular reinforcing structure

(4) has a geometric centre of gravity (G) located at such a position that an axially outer end edge of said annular anchoring insert (19) is pushed towards the rotation axis of the tyre following a tension generated along said at least one carcass ply (3), by effect of the tyre inflating pressure.

25. A tyre as claimed in claim 21, wherein the cross section profile of each annular reinforcing structure (4) has a geometric centre of gravity (G) located at an axially outer position relative to said stiffening element (20) and at an axially inner position relative to an axially outer end edge of said annular anchoring insert (19).

26. A tyre as claimed in claim 21, wherein said at least one carcass ply has a first and a second part defining axially inner terminal zones (15) and axially outer terminal zones (16), respectively.

27. A tyre as claimed in claim 26, wherein said stiffening element (20) is axially interposed between the respective axially inner terminal zone (15) and the respective axially outer terminal zone (16) of said at least one carcass ply (3).

28. A tyre as claimed in claim 26, wherein said annular anchoring insert (19) is applied against an end portion (17) of said inner terminal zone (15), extending axially away from an equatorial plane (X-X) of the tyre.

29. A tyre as claimed in claim 28, wherein said annular anchoring insert (19) is applied at a radially outer position relative to said end portion (17) of the inner terminal zone (15).

30. A tyre as claimed in claim 21, wherein said stiffening element (20) comprises at least one annular body of elastomer material.

31. A tyre as claimed in claim 30, wherein said annular body has a hardness not lower than 48° Shore D.

32. A tyre as claimed in claim 21, wherein said annular anchoring insert (19) is disposed substantially close to an inner circumferential edge of the primary portion (21) of the stiffening element (20).

33. A tyre as claimed in claim 21, wherein said stiffening element (20) has, at a radially inner position, an extension portion (22) substantially stretching out parallelly of said annular anchoring insert (19).

34. A tyre as claimed in claim 21, further comprising at least one additional annular insert (23) extending parallelly of said annular anchoring insert (19).

35. A tyre as claimed in claims 26 and 34, wherein said additional annular insert (23) is applied against an end portion (18) of said outer terminal zone (16), extending axially away from an equatorial plane (X-X) of the tyre.

36. A tyre as claimed in claim 35, wherein said additional annular insert (23) is applied at a radially outer position relative to said end portion (18) of the outer terminal zone (16).

37. A tyre as claimed in claim 21, wherein said at least one carcass ply (3) comprises at least one first

series of elongated sections (13) circumferentially distributed around said rotation axis and each extending in a U-shaped configuration around the cross-section profile of the carcass structure (2) to define two side portions (13a) mutually spaced apart in an axial direction, and a crown portion (13b) extending at a radially outer position between the side portions (13a).

38. A tyre as claimed in claim 37, wherein said at least one carcass ply (3) further comprises at least one second series of elongated sections (14), circumferentially distributed in an alternate sequence relative to the sections (13) belonging to the first series around said rotation axis and each extending in a U-shaped configuration around the cross-section profile of the carcass structure (2) to define two side portions (14a) mutually spaced apart in an axial direction, and a crown portion (14b) extending at a radially outer position between the side portions (14a), on the side portions (13a, 14a) of the sections (13, 14) belonging to the first and second series being respectively defined axially inner terminal zones (15) and axially outer terminal zones (16) of said carcass ply (3).

39. A tyre as claimed in claim 26, wherein said annular anchoring insert (19) is applied against an end portion (18) of said inner terminal zone (16), extending axially away from an equatorial plane (X-X) of the tyre.

40. A tyre as claimed in claim 39, wherein said annular anchoring insert (19) is applied at a radially outer position relative to said end portion (18) of the outer terminal zone (16).

41. A tyre as claimed in claim 40, wherein the end portion (18) of the outer terminal zone (16) is applied in radial superposed relationship against an end portion (17) of the inner terminal zone (15).

42. A tyre as claimed in claim 21, further comprising at least one additional circumferentially-inextensible annular insert (23) having a cross section profile extending radially against an axially inner wall of the primary portion (21) of said stiffening element (20).

43. A tyre as claimed in claim 21, wherein said stiffening element (20) is placed at an axially outer position relative to said at least one carcass ply (3).

44. Tyre wheel for vehicles, comprising a mounting rim which can be associated with a hub of said vehicle and a tyre mounted on said rim,
said tyre comprising a toroidal carcass structure (2) provided with a crown portion connected to a pair of axially opposite sidewalls terminating in beads for engagement with corresponding bead seats formed on the mounting rim, said carcass being provided with at least one reinforcing ply (3) having terminal zones (15, 16) engaged with respective annular reinforcing structures (4) axially spaced from one another,
the radially external surface of said rim having two lateral portions which are designed to form said bead seats for engagement with the corresponding beads of said tyre, defined by frustoconical surfaces converging towards the axis of rotation of the rim, away from the equatorial plane thereof,

said wheel being characterized by the fact that at least one of said annular reinforcing structures (4) comprises at least one stiffening element (20) applied against said at least one carcass ply (3) and having at least one main portion (21) with a cross-sectional profile tapering away from an axis of rotation of the tyre, and at least one circumferentially unextendable, annular, anchoring insert (19, 23) formed by winding at least one continuous filament-like element in coaxial turns (19a, 23a) and that at least one of said bead seats forms per se a hump high enough to prevent bead unseating of the corresponding bead of said tyre.

45. Tyre wheel according to Claim 44, characterized in that said annular anchoring insert (19) has a cross-sectional profile with a flattened form extending axially away with respect to the main portion (21) of said stiffening element (20) and in that at least one of said bead seats is delimited axially towards the inside by a bead unseating safety hump with a diameter not less than the radially external diameter of the axially innermost turn of said annular anchoring insert (19).

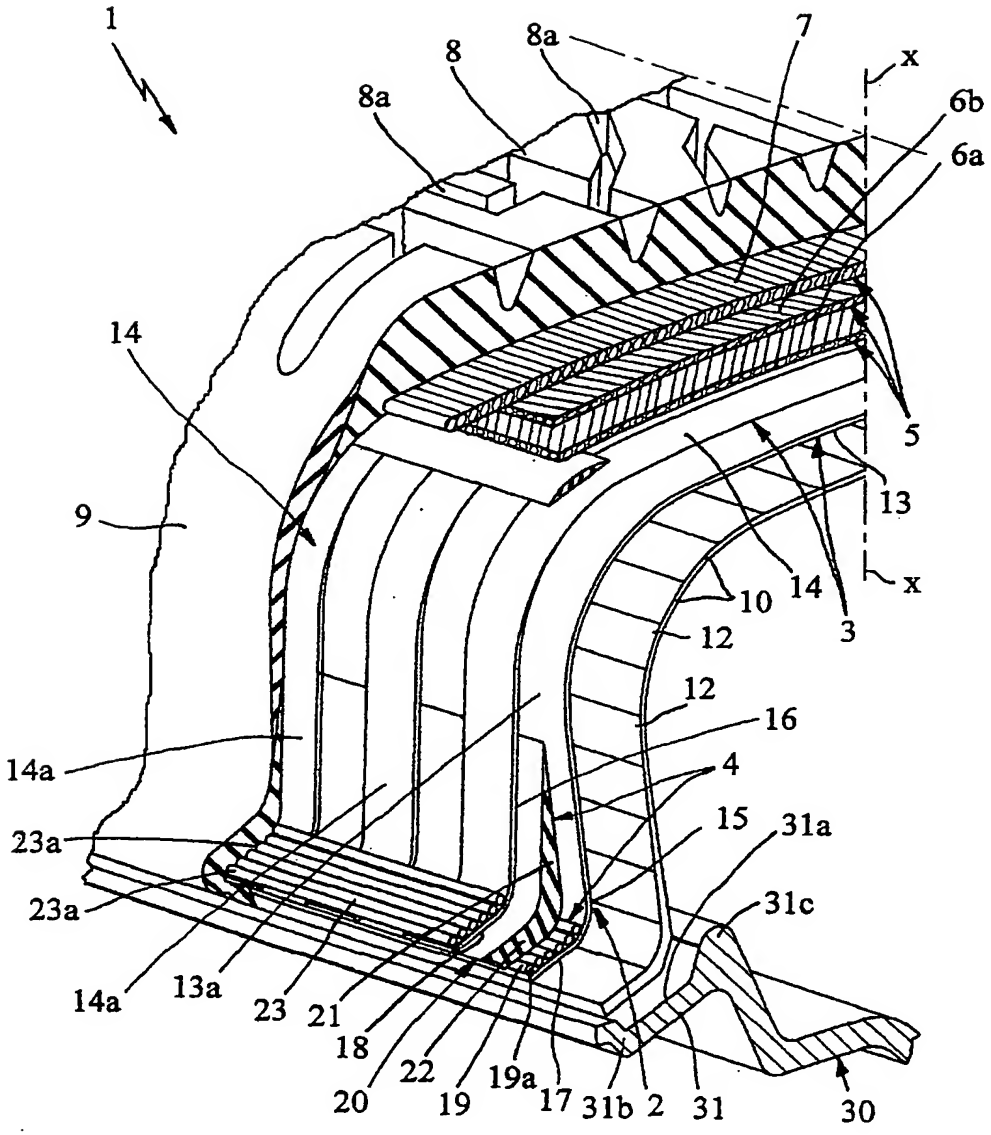
46. Tyre wheel according to Claim 44 or Claim 45, characterized in that said annular anchoring insert (23) has a cross-sectional profile in radially concentric turns (23a) extending radially against a wall of the main portion (21) of said stiffening element (20) and in that the diameter of said bead unseating safety hump has a value not greater than the radially external diameter of the radially

innermost turn of said annular anchoring insert (23).

47. Tyre wheel according to Claim 44, characterized in that the radially external surface of said rim comprises a central portion with a radially external profile symmetrical with respect to the equatorial plane, which defines a central well axially delimited by said bead seats, said well having a minimum diameter D_r less than the minimum diameter D_m of said seats.

48. Tyre wheel according to Claim 44, characterized in that it comprises an inner tube which is inserted into said toroidal cavity and is elastically expandable by means of the introduction of pressurized fluid into its internal volume and which comprises at least two circumferential volumes which are separated from and independent of one another and separated by a longitudinal wall extending in a plane perpendicular to the axis of rotation of the wheel, each of said volumes being provided with an inflation and deflation device which is contained in the wall of said inner tube and does not have any connection with said rim designed to fix the circumferential position of said chamber with respect to the rim.

Fig. 1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4
15
31a
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Fig. 2

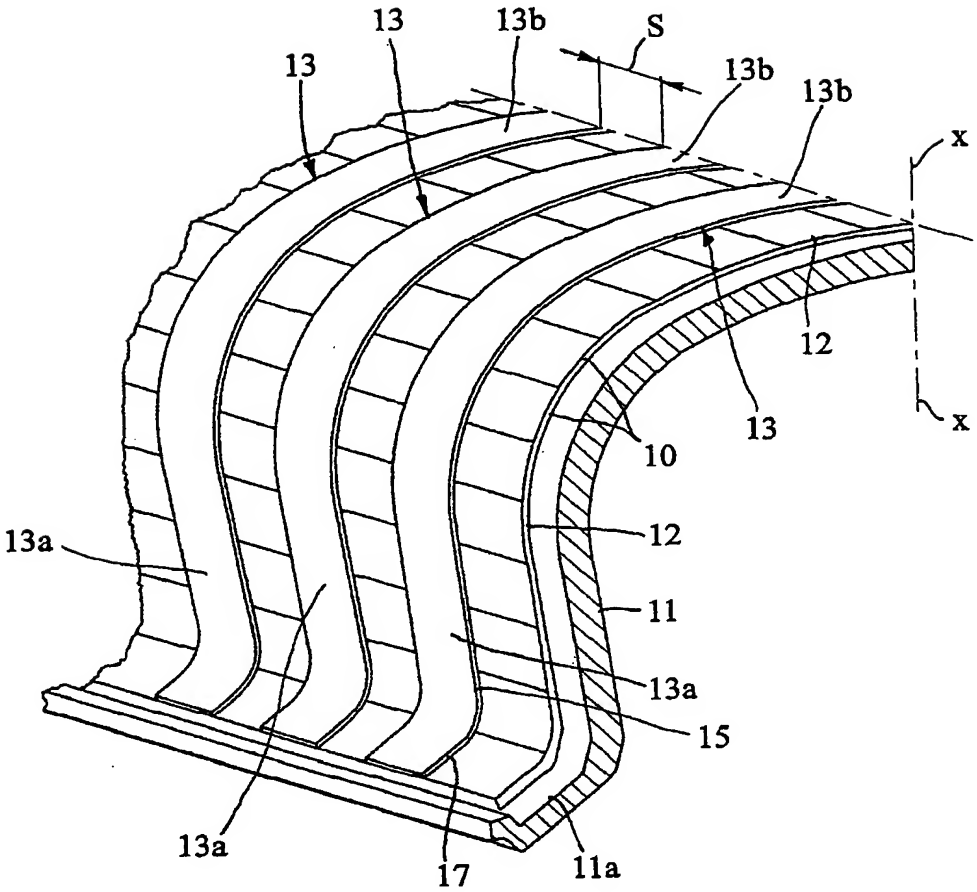
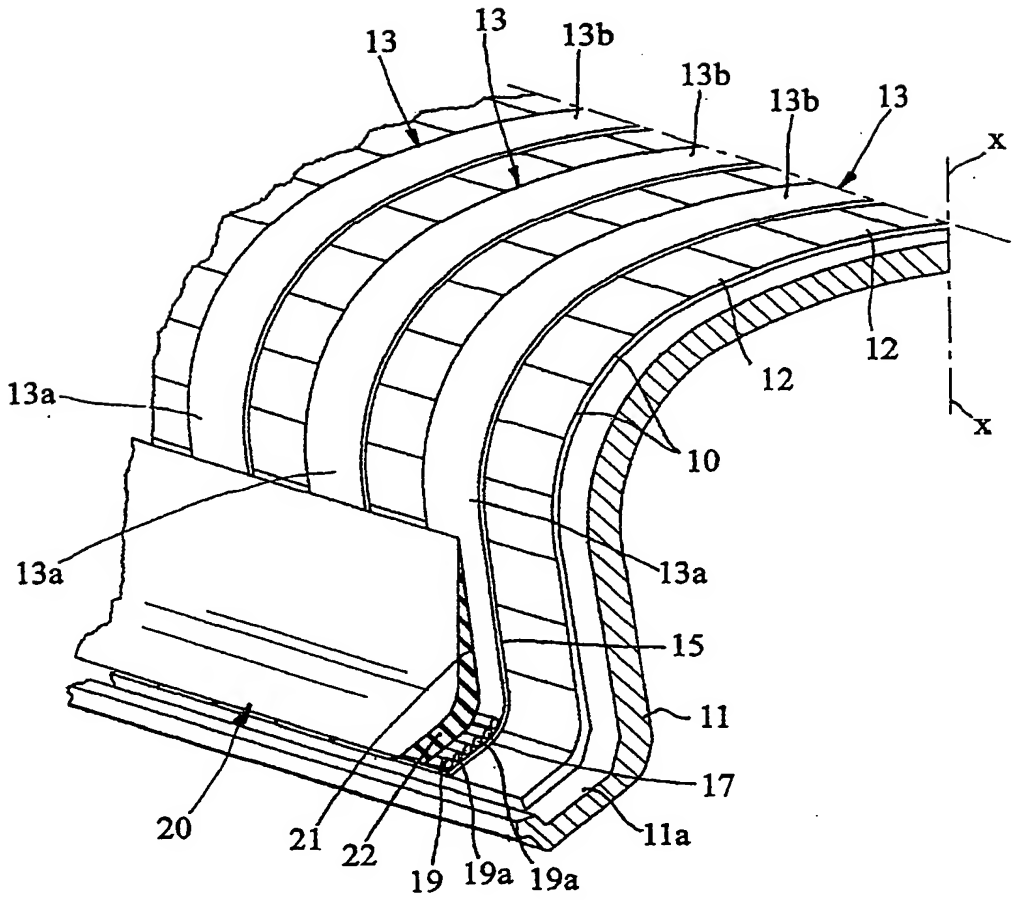


Fig. 3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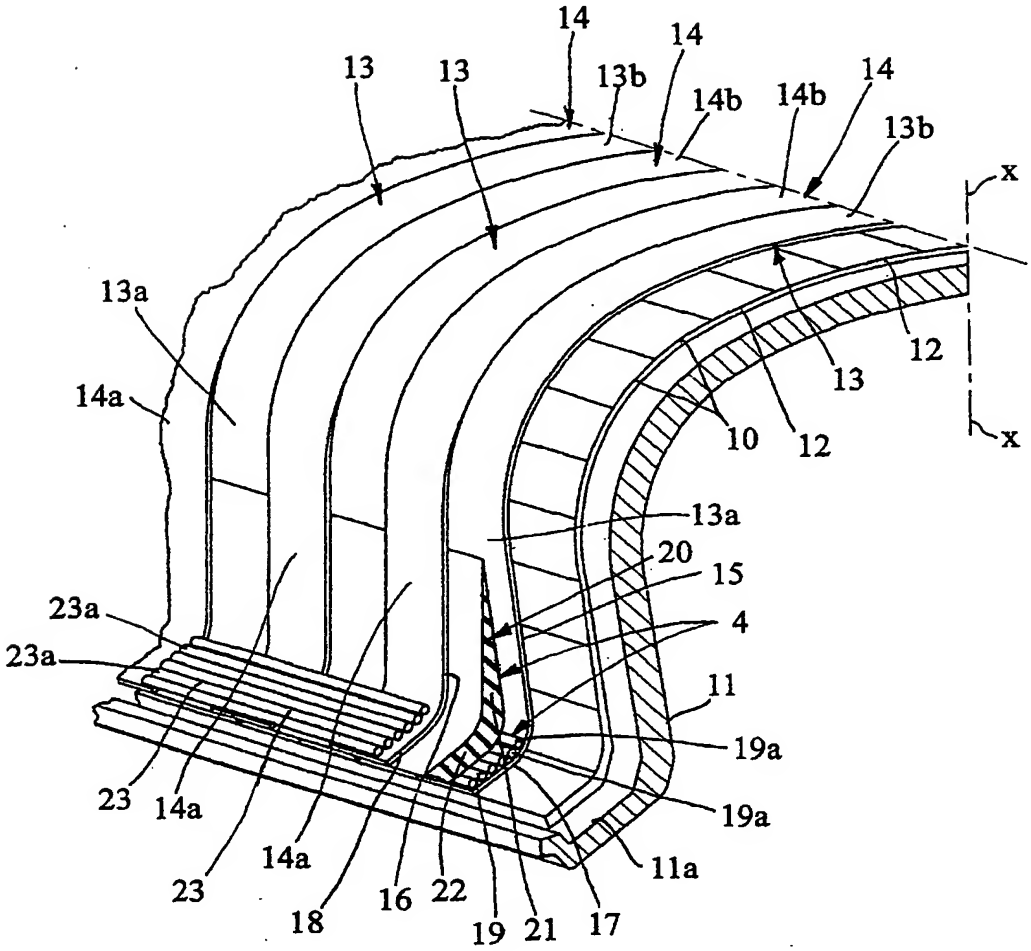
19a

Fig. 4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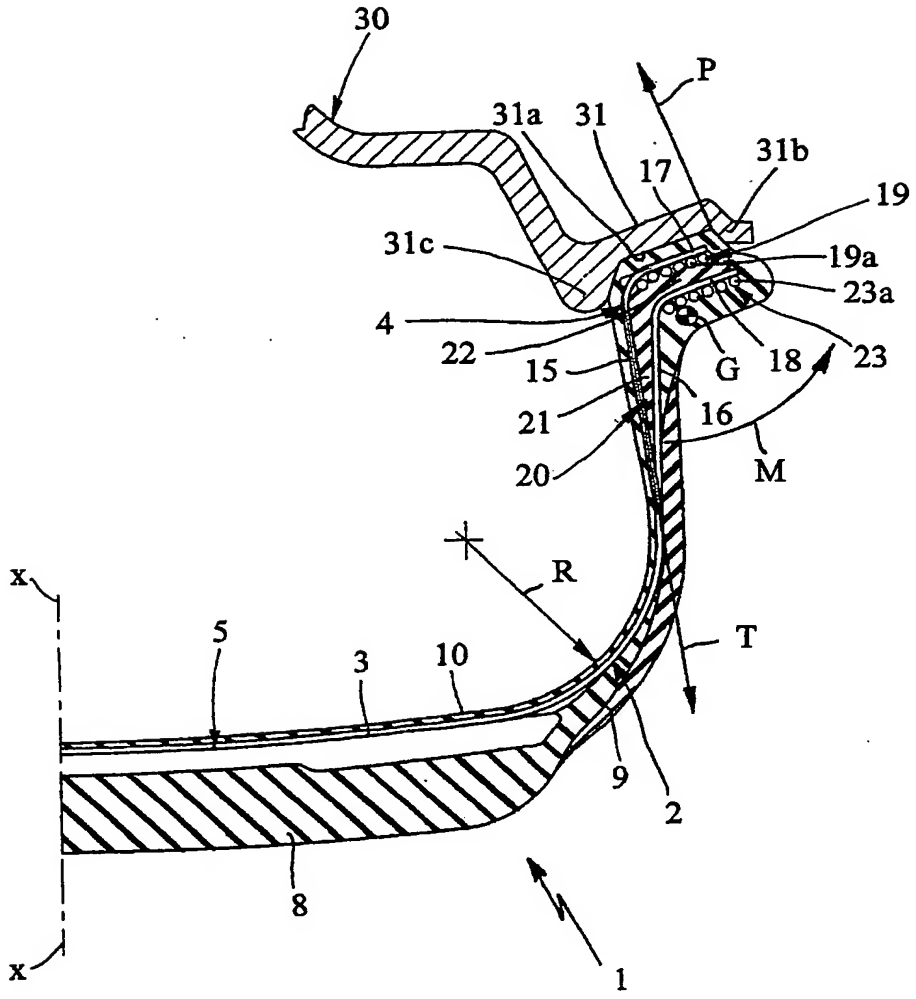
19
21
17

Fig. 5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x

Fig. 6

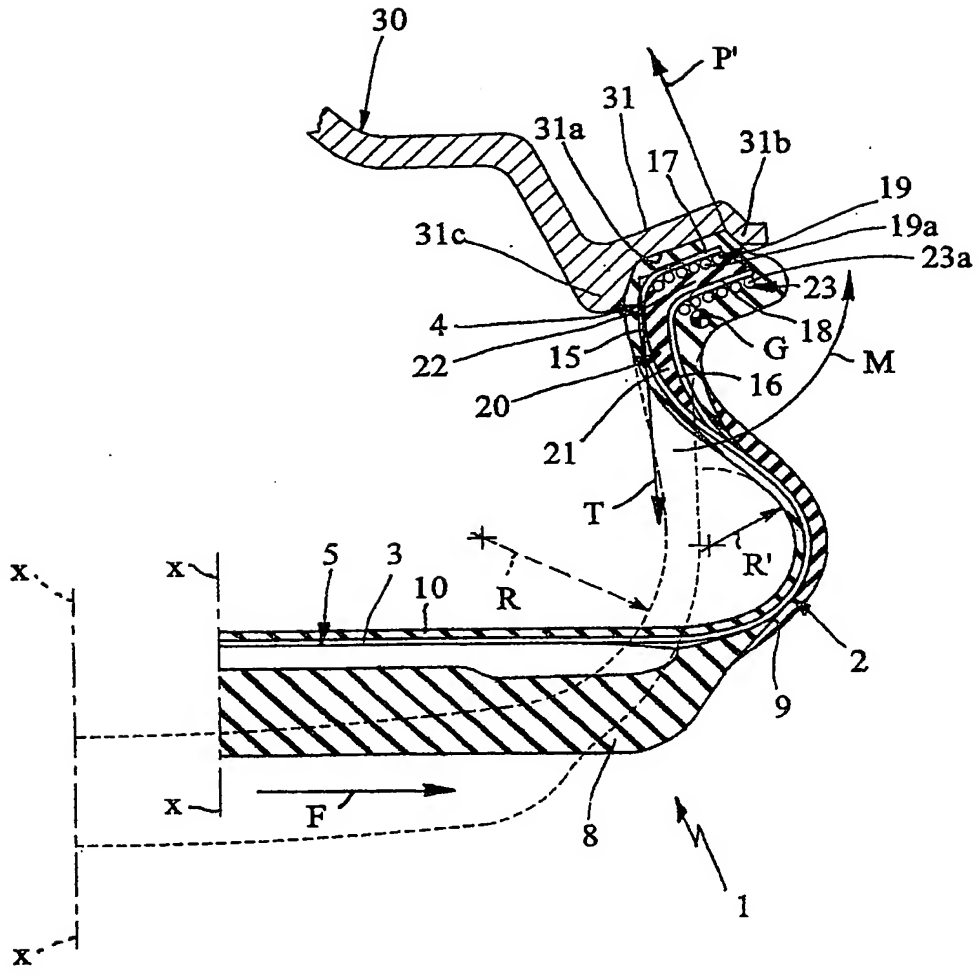
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Fig. 7

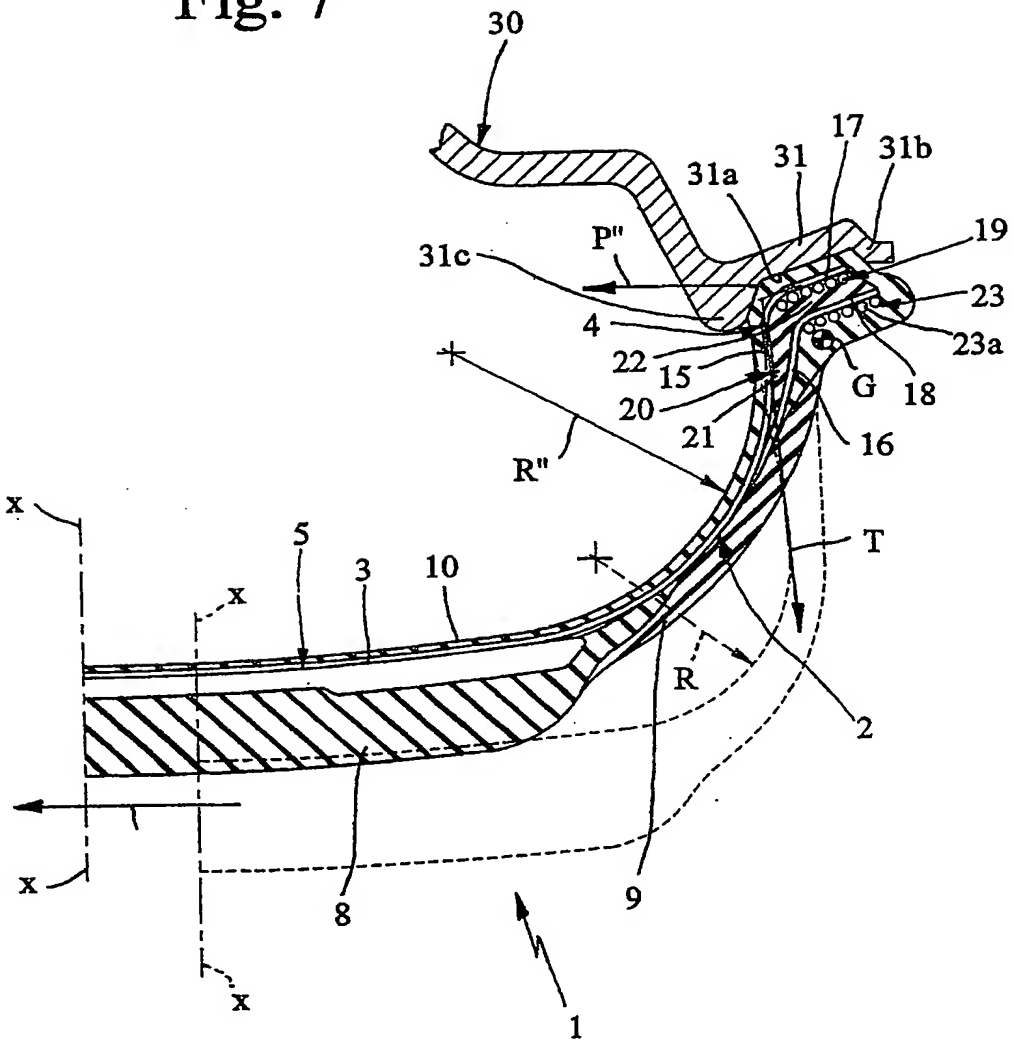
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Fig. 8

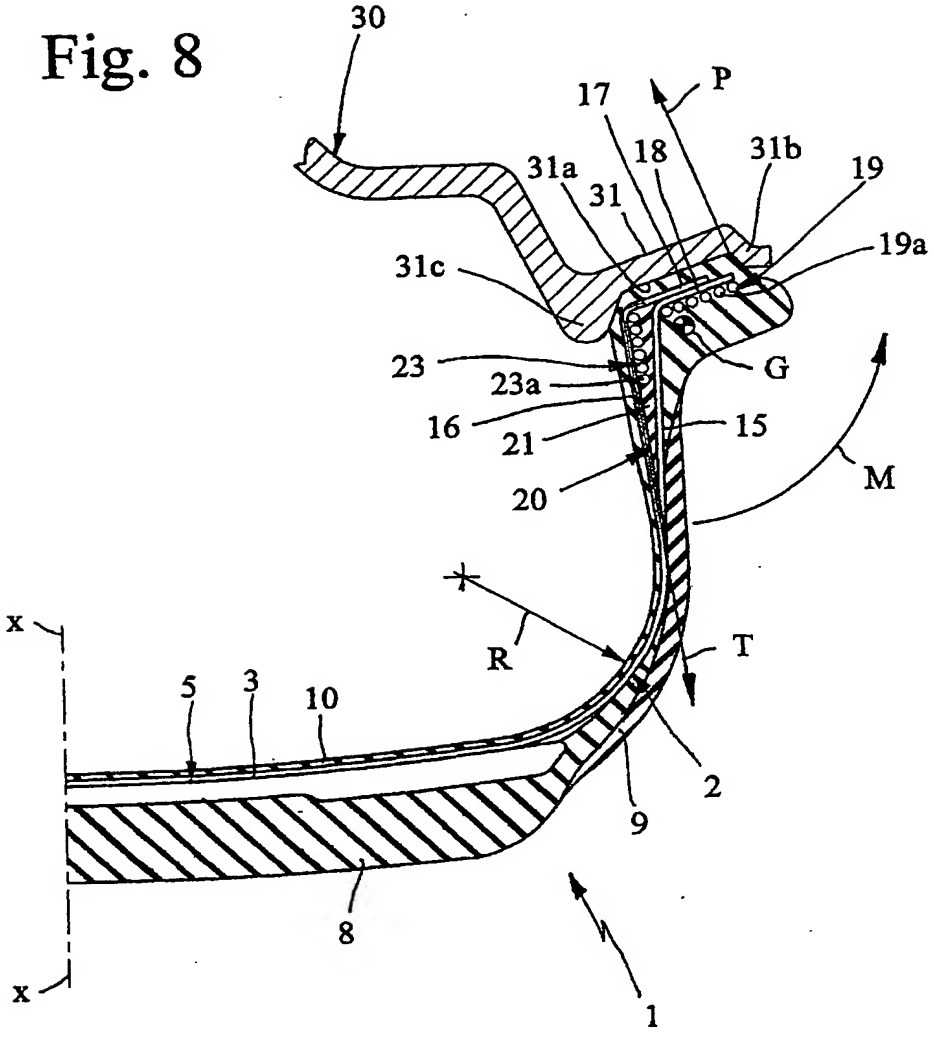
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Fig. 9

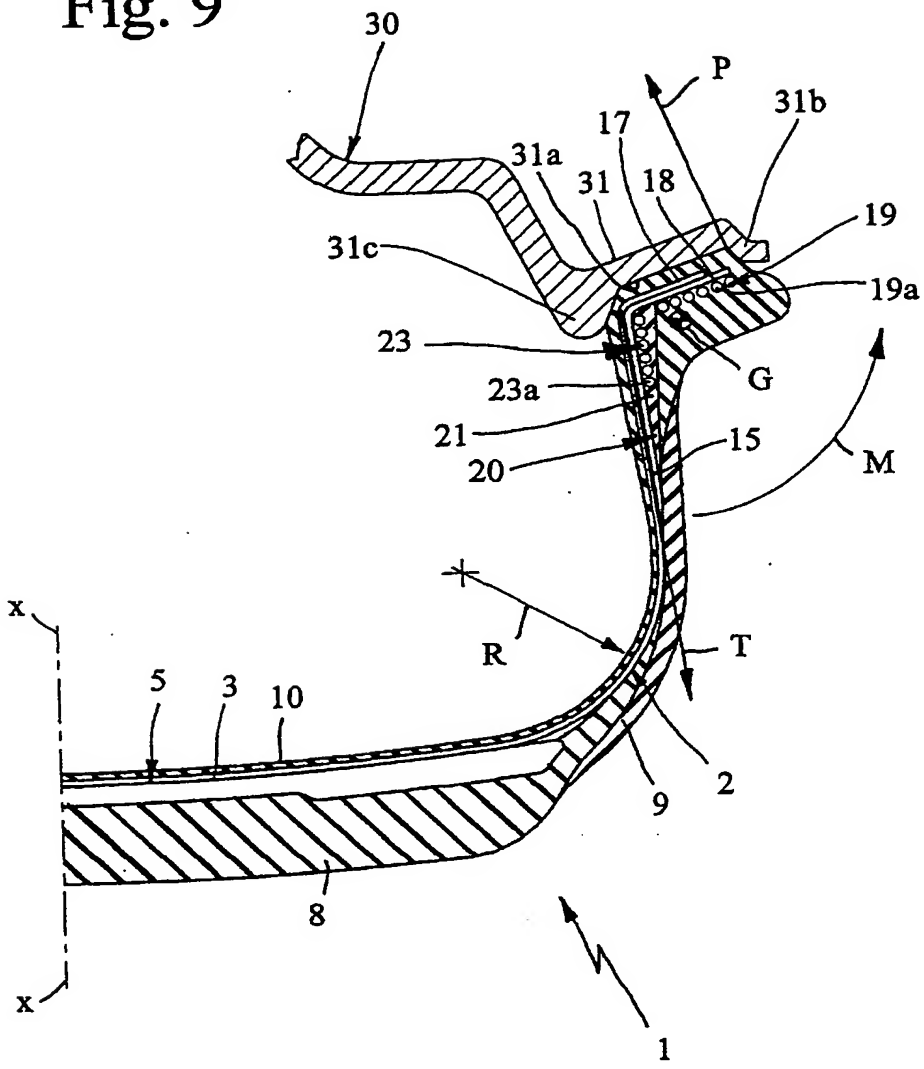
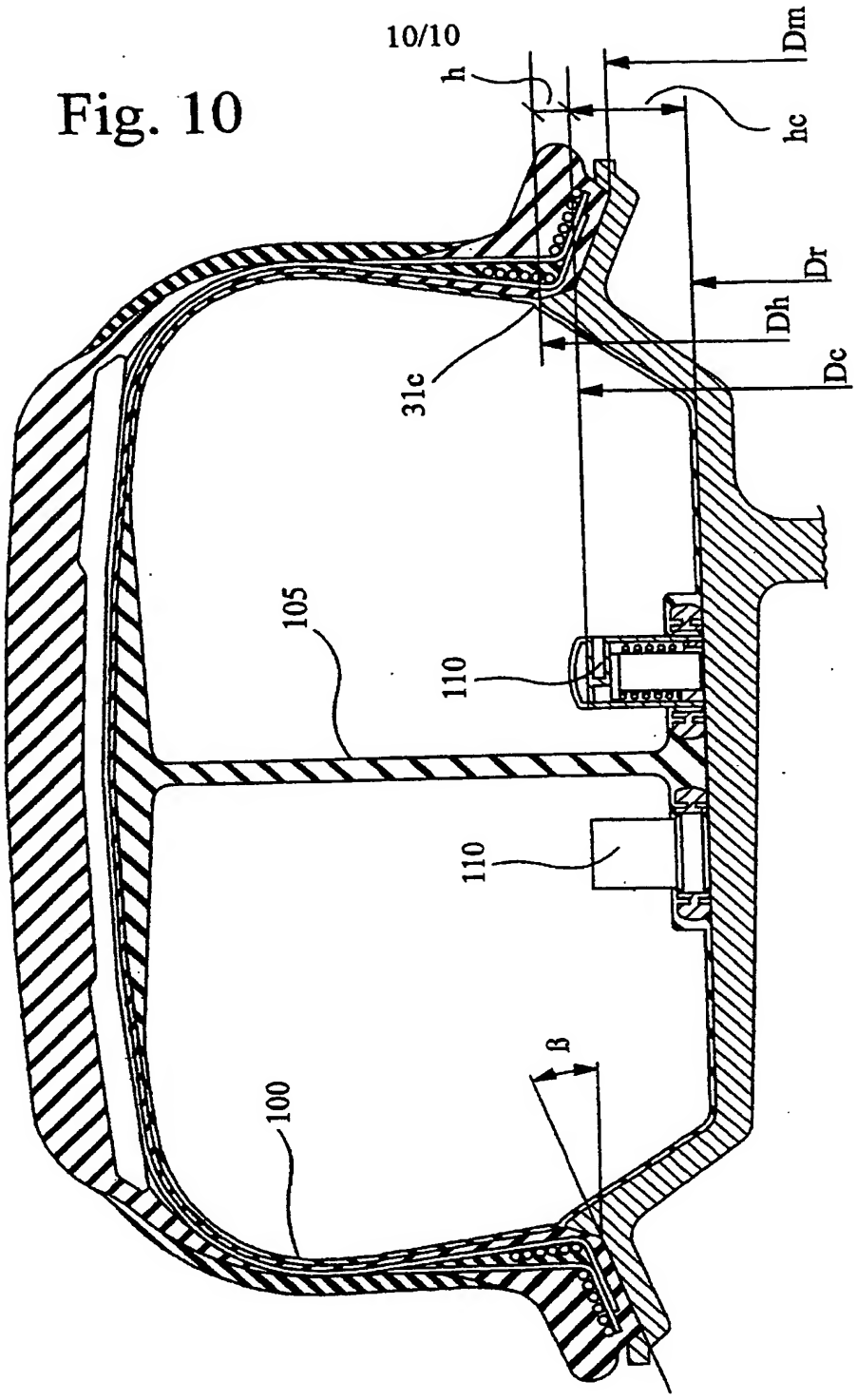


Fig. 10



INTERNATIONAL SEARCH REPORT

Int tional Application No
PCT/EP 99/03664

A. CLASSIFICATI N OF SUBJECT MATTER
IPC 6 B29D30/10 B29D30/18 B29D30/48 B60C9/02 B60C15/00
B60C15/05

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60C B29D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
30 August 1999	10/09/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Fregosi, A

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INTERNATIONAL SEARCH REPORT

In tional Application No
PCT/EP 99/03664

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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In tional Application No
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